INSTRUCTION MANUAL

AUTO-NODE 792-A

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KAY ELECTRIC CO.
PINE BROOK, N. J.

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AUTO-NODE

Catalog No. 792-A

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SECTION I
GENERAL INFORMATION

1.1 INTRODUCTION.

The Auto-Node is a fast-acting, sensitive system used for checking receiver noise against a known, controlled noise level. Any changes in receiver noise are shown on the direct-reading panel meter that reads measured noise figure.

Operating range of input noise power is -75 dbm to 0 dbm for a nominal 1-mc bandwidth. About 33 db of external gain between the IF input and its lowest output noise source is required with a 1 mc bandwidth. A built-in step attenuator provides 41 db of attenuation in 1-db increments. AGC with a dynamic range of 40 db is provided. A continuously variable range of input frequencies from 10 to 120 mc is provided to permit use with a wide variety of receiver IF's.

1.2 AUTO-NODE NOISE HEADS.

A. Hot Wire Noise Head.

The standard noise head normally supplied with the Auto-Node is a hot wire noise source with a 50-ohm output impedance. Frequency range of this noise head is 10 to 900 mc.

B. Microwave Mega-Node Noise Heads.

Any of these argon noise sources may be used with the Auto-Node. They must be ordered separately.

311-A	1200 - 1400 mc	291-A	7050 - 10000 mc
261-A	2600 - 3950 mc	301-A	8200 - 12400 mc
271-A	3950 - 5850 mc	521-A	12400 - 18000 mc
281-A	5850 - 8200 mc	531-A	18000 - 26500 mc

C. Special Purpose Heads.

The following noise heads, supplied only when specifically ordered by the customer, are designed for particular application.

NB 300: Balanced 300 ohms output covers FM & TV-VHF frequencies.

NM 781: 50 ohm coaxial output covers full 3000 mc UHF range.

NC 240: 50 or 70 ohms coaxial output covers FM and TV-VHF frequencies.

1.3 SPECIFICATIONS.

Noise Figure Ranges: 5 - 30 db (15.2 db noise source - gas tube or diode heads)
0 - 20 db (6.0 db noise source - pinlite or diode heads)
0 - 15 db (5.2 db noise source - gas tube or diode heads)

Accuracy: ± 0.5 db

Input Frequency: 10 thru 120 mc continuous coverage, selected from front panel.

Bandwidth: Approx. 4% of center frequency.

Input Sensitivity (Noise Source On): 0 to -75 DBM, monitored by noise power meter (approx. 33 DB minimum gain between noise source and Type 792A for 1 mc bandwidth).

Input Impedance: 50 ohms nominal

Input Attenuator: Steps of 20, 10, 5, 3, 2 and 1 db.

Noise Diode Current Metering: Three ranges: X.5, X2 and X10 with scale reading of 2 ma average current. (Gives full scale average current reading of 1, 4, and 20 ma).

Noise Diode Current: 0.1 to 20 ma in two ranges.

Line Power Input: 115/230 VAC ± 10%, 50 - 60 cps, approx. 10 watts (45 watts with diode pulser connected).

Dimensions: 19 x 7 x 11" deep.

SECTION II
INSTALLATION

2.1 INSTALLATION.

As soon as the Auto-Node is received, it should be visually inspected to determine that the instrument was not damaged during shipment. Any damage or shortage should be reported immediately to the carrier and the Kay Electric Company, or its representative in the area.

The standard Auto-Node is mounted in a metal cabinet and contains a built-in power supply. All essential circuits for making noise figure measurements are provided. Noise heads must be specifically ordered by the customer. Auxilliary equipment and cables, mentioned in this manual, are not furnished. It is recommended that sufficient space be allotted to avoid obstruction of the ventillating grating. Space should also be provided for equipment which is to be used in conjunction with the Auto-Node. Extreme variations of ambient temperature and an environment having excessive humidity should also be avoided. Observance of these precautions will result in optimum performance.

2.2 OPERATING NOTES.

The noise output impedance varies with the type of head being used (output impedances of the various noise sources are given in Section 1.2. Input impedance of the Auto-Node is 50 ohms. If the impedances of the remainder of the system differ substantially from these values, impedance matching devices must be used.

All connections should be made with coaxial cable having the proper impedance and appropriate coaxial connectors. It is generally considered good practice to keep interconnecting cables short when working with rf. A basic interconnection diagram is supplied in Fig. 2.1. Depending upon the device being tested and the noise source head being used, an auxiliary amplifier or an attenuator may be required between the output of the device and the input of the Auto-Node.

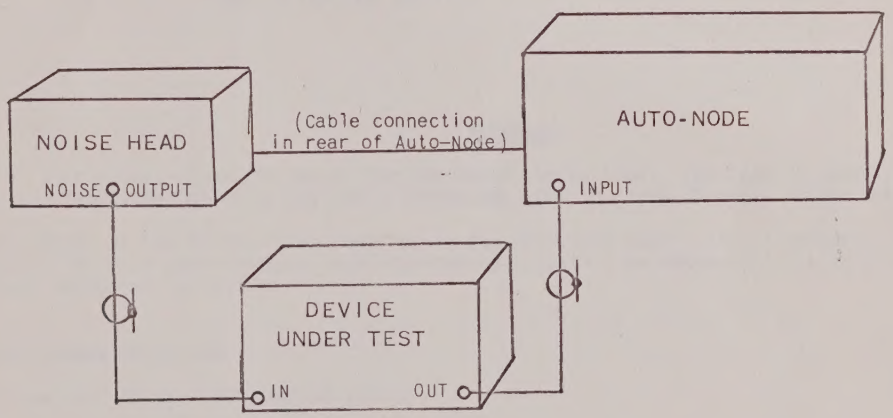

Fig. 2.1 Interconnection diagram, Auto-Node.

SECTION III
OPERATION

3.1 EXTERNAL CONTROLS.

CONTROL	POSITION	FUNCTION
COARSE S-301	11 position rotary	Set to approximate center frequency of device being tested.
FINE C-348	Variable	Used in conjunction with COARSE control to tune the input of the Auto-Node to the exact center frequency of the device being tested. Control is properly set when the Noise Power Level meter shows a peak reading, as explained in Section IV. A screwdriver adjustment is provided for locking control in any position.
NF METER FUNCTION Switch S-2	CALIBRATE	Used to set automatic noise figure meter at infinity before measurements are made.
	NOISE FIGURE	Noise measurements are made directly from Automatic Noise Figure meter when in automatic operation.
	DIODE CURRENT X10, X2, X0.5	Used to set diode current of the noise diodes. The three positions are multipliers for the current scale of the meter.

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CONTROL	POSITION	FUNCTION
INPUT ATTENUATOR Switches S-302 thru S-307	Stepped	Precise steps of 20, 10, 5, 3, 2 and 1 db may be inserted to reduce input noise level for on-scale readings of the Automatic Noise Figure meter.
SET TO INFINITY R-158	Variable	Used to set Automatic Noise Figure meter at infinity when the NF METER FUNCTION switch is in the CALIBRATE position.
Diode Current R-377 & R-378	Variable	Set noise diode current to proper level for desired noise power output..
Power Switch S-1	OFF	Auto-Node is completely de-energized.
	MAN	Used in conjunction with noise diode pulser when manual operation is desired.
	AUTO	Automatic Noise Figure meter constantly monitors the noise figure of the device being tested.
GAIN R-367 & R-370	Variable	Controls gain of Auto-Node amplifiers when manual noise figure measurements are being made.
MANUAL - AUTO Switch S-1 (Located on rear of diode pulser chassis)	MANUAL ON	The diode current may be set, during manual operation, as explained in Section 3.4B. With the switch in this position, the device under test receives noise continuously from the noise diodes.
	MANUAL OFF	The gain of the Auto-Node may be set, during manual operation, by means of the GAIN control, as explained in Section 3.4B. With the switch in this position, the device under test is supplied only with Johnson noise.
	AUTO	The Auto-Node is set for automatic noise figure readings. This switch need not be set when the hot-wire source head is being used.
HIGH - LOW Switch S-2 (Located on rear of diode pulser chassis)	HIGH	When the peak diode current is greater than about 7.0 ma, the switch must be set to the HIGH position.
	LOW	When the peak diode current is less than about 7.0 ma, the switch must be set to the LOW position.

3.2 TERMINALS.

TERMINAL	FUNCTION
NOISE OUTPUT	The noise output signal is taken from the noise source head. The type of connector and the output impedance (given in Section 1.2) depends upon the type of noise source used.
INPUT J-1	The output of the device being examined is fed into this jack. Signal frequencies between 10 and 120 mc with approximately 30 db minimum gain (with 1 mc bandwidth) are acceptable. The input impedance is 50 ohms.

3.3 HOT WIRE NOISE SOURCE OPERATION.

1. Connect line cord to 117-volt, 60 cps source.
2. Interconnect equipment as shown in Fig. 2.1.
3. Switch all attenuation out.
4. Set COARSE control to approximate output frequency of device under test.
5. Insert sufficient attenuation to reduce the Noise Power Level meter reading to below half-scale.
6. Adjust FINE control for a maximum reading on the Noise Power Level meter.
7. Set attenuator switches for a Noise Power Level meter reading in the white OPERATE area. (If a wide band amplifier is being tested, the Noise Power Level meter reading should be kept below 1/2 scale to avoid overloading the Auto-Node wide band amplifier.)
8. Place NF METER FUNCTION switch in the CALIBRATE position.
9. Adjust the SET TO INFINITY control until the Automatic Noise Figure meter reads infinity.
10. Place NF METER FUNCTION switch in NOISE FIGURE position.
11. Read noise figure directly from second noise source scale (6 db at center of scale) of the Automatic Noise Figure meter.

3.3 B. MANUAL OPERATION

Method I.

1-9 Repeat Steps 1-9 of 3.3A.

10. Turn POWER Switch to MANUAL.

11. Adjust GAIN control pot and input attenuation if necessary until the AUTOMATIC NOISE FIGURE METER reads infinity.

12. Remove 7921-A from device under test and replace with 50 ohm termination.

13. Read noise figure directly from 6 DB Scale. Same as in automatic measurement.

Method II.

1-10 Repeat Steps 1-10 of Method I.

11. Remove 7921-A from device under test and replace with a 50 ohm termination.

12. Adjust GAIN Control pot and input attenuators if necessary until the AUTOMATIC NOISE FIGURE METER reads 1 on the current scale (Mid Scale).

13. Remove 50 ohm termination from device under test and replace with 7921-A.

14. Turn NF METER FUNCTION SWITCH to CALIBRATE. Insert 3 db attenuation from the 792-A. Record the reading on the current scale. Call this I.

15. Noise Figure may be calculated from the expression:

$$F=10 \text{ Log } 10\left[\frac{(2)}{(I-\frac{1}{2})}\right]$$

16. This method can be made more accurate by using a pad or attenuation from the 792-A which will give a value of I closer to 1 ma than the reading obtained in step 13. The procedure is the same as with 3 DB of attenuation except the formula changes:

$$F=10 \text{ Log } 10\left[\frac{4}{aI-1}\right]$$ where a is the amount of attenuation used as a multiplier (Not DB)

Method III.

1-10 Same as 1-10 of Method I.

11. Adjust GAIN control pot and input attenuators if necessary until the AUTOMATIC NOISE FIGURE METER reads infinity.

12. Insert a pad or attenuation a between the 7921-A and the device under test.

13. Record the reading on the current scale and convert the reading to an S factor by the formula $S=\frac{2}{I}$ where I is in milliampereres.

14. Calculate the noise figure from the formula:

$$F=10 \text{ Log } 10\ 4\left[\frac{(a-s)}{a(s-1)}\right]$$

where a is a multiplier (Not DB)

3.4 OPERATION WITH DIODE NOISE SOURCES (NC240, NB300, and NC780).

A. Automatic Operation.

1. Determine the desired noise scale to be used. The required excess noise power corresponds to the center reading of the scale (15.2 db, 6 db, and 5.2 db, reading scales from top to bottom).

2. Determine the peak diode current required to produce this excess noise power from the relationship:

$$F = 20IR \quad (1)$$

Where F = excess noise power (expressed as a ratio)
I = diode plate current
R = characteristic output impedance of noise source head.

The excess noise power may be expressed in db, as follows:

$$F_{(db)} = 10 \log F \quad (2)$$

Where $F_{(db)}$ = excess noise power in db

3. Connect line cord to 117-volt, 60 cps source, and interconnect equipment as shown in Fig. 2.1.

4. Switch all attenuation out and place MANUAL – AUTO switch (located on rear of diode pulser chassis) in AUTO position.

5. Set LOW – HIGH switch in proper position. If the peak diode current, computed in Step 2, is less than about 7.0 ma, this switch should be in the LOW position. When higher peak currents are used, this switch should be in the HIGH position.

6. Set COARSE control to approximate output frequency of device under test.

7. Insert sufficient attenuation to reduce the Noise Power Level meter reading to below half-scale.

8. Adjust FINE control for a maximum reading on the Noise Power Level meter.

9. Set attenuator switches for a Noise Power Level meter reading in the white OPERATE area. (If a wide-band amplifier is being tested, the Noise power Level meter reading should be kept below 1/2 scale to avoid overloading the Auto-Node input amplifier.)

10. Place NF METER FUNCTION switch in CALIBRATE position.

11. Adjust SET TO INFINITY control for an automatic Noise Figure meter reading of infinity.

12. Set NF METER FUNCTION switch to required diode current range.

13. Adjust DIODE CURRENT control for the required peak diode current, computed in Step 2, as shown on the current scale of the Automatic Noise Figure meter. Note that meter reads average current and since the diode is square wave modulated, the average current is one half peak current.

14. Set NF METER FUNCTION switch to NOISE FIGURE and read the noise figure from the scale determined in Step 1.

    Example: Suppose that a noise head source with a characteristic output impedance of 50 ohms is being used, and an excess noise power of 6 db is required From (2) the excess noise power factor is determined ($F \approx 4$). From (1), the peak diode current required for this excess noise power may be determined (I = 4 ma). Steps 3 through 10 of the operation procedure are then followed (the LOW – HIGH switch should be in the LOW position). The NF METER FUNCTION switch should be placed in t the X2 position, and the DIODE CURRENT control set for a reading of 2 ma (pointer indication of 1 ma) on the Automatic Noise Figure meter. The NF METER FUNCTION switch is then placed in the NOISE FIGURE position, and the noise figure of the device is read on the center noise figure scale (6 db excess noise power) of the Automatic Noise Figure meter.

B. Manual Operation.

The NC240, NB300, and NC780 diode noise source heads may be operated manually, using the following procedures.

1. Connect line cord to 117-volt, 60 cps source, and interconnect equipment as shown in Fig. 2.1.

2. Set power switch to AUTO and MANUAL – AUTO switch (rear of diode pulser chassis) to AUTO.

3. Set COARSE control to approximate output frequency of device under test and insert sufficient attenuation to reduce the Noise Power Level meter reading to below half-scale.

4. Adjust FINE control for a maximum reading on the Noise Power Level meter.

5. Set attenuator switches for a Noise Power Level meter reading in the white OPERATE area. (If a wide-band amplifier is being tested, the Noise Power Level meter reading should be kept below half-scale to avoid over-loading the Auto-Node input amplifier).

6. Place NF METER FUNCTION switch in the CALIBRATE position, and adjust SET TO INFINITY control until the Automatic Noise Figure meter reads infinity.

7. Set Power switch to MAN and MANUAL - AUTO switch (rear of diode pulser chassis) to MANUAL - OFF. Adjust GAIN control to provide any convenient reading on the Automatic Noise Figure meter.

8. Set MANUAL - AUTO switch to MANUAL ON, insert 3 db attenuation, and adjust DIODE CURRENT control to give the same Automatic Noise Figure meter reading as observed in Step 7. Note: In order to obtain this reading, the position of the HIGH - LOW switch (rear of diode pulser chassis) may have to be changed.

9. Repeat Steps 7 and 8 until no further adjustment is necessary.

10. Set the NF METER FUNCTION switch to the lowest DIODE CURRENT position which will provide an "on-scale" reading of the Automatic Noise Figure meter. (Read the current scale with the appropriate multipliers indicated by the NF Meter Function switch setting).

11. The noise figure may be computed from the formula:

$$F = 10 \log (20IR)$$

Where I = diode plate current
R = noise head impedance

3.5 THE MICROWAVE MEGA-NODE NOISE SOURCES.

The Microwave Mega-Node noise sources consist of the NM781, 311-A, 261-A, 271-A, 281-A, 291-A, 301-A, 521-A, and 531-A. They are used in conjunction with the Waveguide Noise Source Pulser 324-B.

A. Automatic Operation.

1. Interconnect equipment as in Fig. 3.1.

2. Turn NF METER FUNCTION SWITCH to CALIBRATE. Turn FUNCTION switch (OFF - MAN - AUTO) on 792-A to AUTO.

3. Turn the 324-B to ON and to AUTO.

4. Wait approximately 30 seconds for the 324-B to warm up. By this time, the gas tube will fire and the TUBE CURRENT METER will indicate the peak current in the tube.

5. Adjust the tube current to read 175 ma (indicated by SET on the meter).

6. Tune and calibrate the 792-A as described previously in 3.3. Steps 3 through 9.

7. Turn NF METER FUNCTION switch of the 792-A to NOISE FIGURE and readjust the tube current, if necessary, to 175 ma. Use the NOISE TUBE CURRENT control, on the 324-B, for this adjustment.

8. Read the noise figure of the device directly from the top (15.2 db excess noise) scale on the AUTOMATIC NOISE FIGURE METER.

B. Manual Operation.

Method 1:

1. Interconnect the equipment as in Fig. 3.1.

2. Turn the 792-A to MAN and NOISE FIGURE. (The CALIBRATE position may be used instead of NOISE FIGURE if desired.)

3. Turn the 324-B to MAN ON. The 324-B must be in AUTO for the gas tube to initially fire. Then and only then will the tube fire when the 324-B is turned to MAN ON.

4. Set the tube current to 175 ma.

5. Adjust the GAIN control on the 792-A until the AUTOMATIC NOISE FIGURE METER reads infinity.

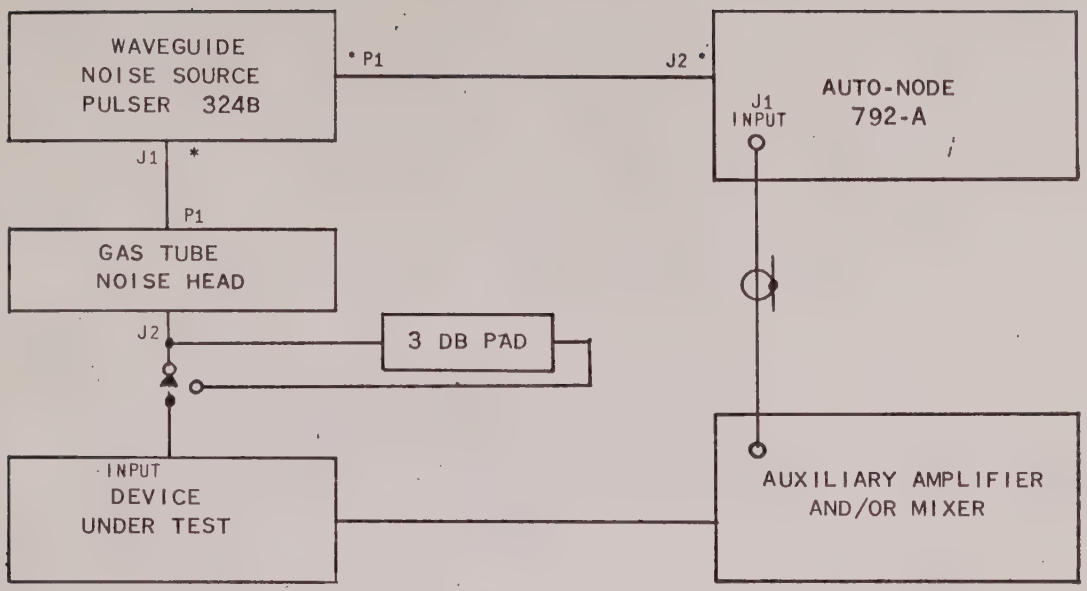
6. Turn the 324-B to MAN OFF.

7. Read the noise figure directly on the top scale of the AUTOMATIC NOISE FIGURE METER.

Method 11:

1. Connect the noise source to be tested to make an automatic measurement.

2. Turn equipment on and allow for warm-up.



*Cable connections on rear of 792A and 324B

Fig. 3.1 Interconnections for Microwave Mega-Node Noise Sources.

3. Turn 792-A to MAN and to CALIBRATE.

4. Turn 324-B to MAN ON and adjust the tube current to 175 ma.

5. Turn the 324-B to MAN OFF.

6. Adjust the GAIN control on the 792-A so that the AUTOMATIC NOISE FIGURE METER reads 1 ma on the current scale.

7. Turn to MAN ON and insert 3 db of attenuation from the 792-A. Record the reading on the current scale. Call this (I).

8. The noise figure may be calculated by the following formula.

$$F = 10 \log \left(\frac{F_s - 1}{2Y' - 1} \right)$$

$$Y' = \frac{1}{I}$$

$F_s - 1$ = Excess noise of the tube

9. This method can be made more accurate by using a pad or attenuator, from the 792-A, which will give a value of I closer to 1 ma than the reading obtained in Step 7. The procedure is the same as with 3 db of attenuation except that the formula changes.

$$F = 10 \log \left(\frac{F_s - 1}{aY' - 1} \right)$$

a = amount of attenuation, used as a multiplier (not db)

Method III:

1. Interconnect the equipment as in Fig. 3.1.

2. Turn the 792-A to MAN and CALIBRATE.

3. Turn the 324-B to AUTO and wait until the 324-B warms up.

4. Turn the 324-B to MAN ON and adjust the tube current to 175 ma.

5. Adjust the GAIN control on the 792-A until the AUTOMATIC NOISE FIGURE METER reads infinity.

6. Insert a 3 db pad between the noise source and the device under test.

7. Record the reading on the current scale and convert the reading to an s factor by the formula ($s = \frac{2}{I}$) where I is in milliamperes.

8. Calculate the noise figure from the formula:

$$F = 10 \log (F_s - 1) \left(\frac{2 - s}{2(s - 1)}\right)$$

$(F_s - 1)$ = excess noise of noise source

$(F_s - 1)$ = 33.1 for an excess noise of 15.2 db.

3.6 EXTERNAL METER FEATURE.

If desired, an external meter may be used for greater readability of low noise figures. The meter can be plugged into a jack at the rear of the Auto-Node. The 792-A will operate exactly the same as it would without the external meter when the function selector is in the OFFSET, CALIBRATE, or NOISE FIGURE position. When the selector is in a DIODE CURRENT position the meters will read approximately one or two per cent low, depending on the resistance of the external meter. In order to obtain accurate readings in this position, the external meter should be removed when adjusting the diode current and then re-inserted after the current has been set.

CAUTION: Do not insert or remove the external meter while in a DIODE CURRENT position. Doing so may permanently damage the external meter as well as the Automatic Noise Figure Meter.

3.7 METER OFFSET CURRENT OPERATION.

The OFFSET CURRENT feature permits a translation of the meter current, by a predetermined amount of current, so that the noise figure may be read with greater accuracy. This is accomplished by reverse-biasing the AUTOMATIC NOISE FIGURE METER so that the 0 db point occurs at a low (or zero) value of meter deflection. The noise figure reading is made in the normal way and this reading corresponds to a value of meter current. The reverse-biasing current (offset current) is then added to this current to obtain the actual noise figure of the device under test.

Method I:

10 ua offset on 6 db scale, using noise source with 6 db excess noise power (Pinlite noise source or diode noise source with proper diode current). This makes the 0 db mark on the 6 db scale correspond to zero meter deflection.

1. Turn OFFSET CURRENT pot to OFF.

2. Turn to CALIBRATE and set to infinity.

3. Turn to OFFSET.

4. Set OFFSET CURRENT until meter reads zero on the 6 db scale.

5. Turn to NOISE FIGURE.

6. Record the reading on the current scale.

7. Multiply the reading in Step 6 by 25×10^{-3} to get the meter current in microamperes. For instance, a reading of 2 ma is equal to 50 ua of meter current, and a reading of .8 ma is equal to a meter current of 20 ua.

8. Add 10 ua to the result obtained in Step 7, and call this total I_m.

9. Find the noise figure from I_m and Table 1, or by the formula:

$$F = 10 \log_{10}\left(\frac{4}{\frac{50}{I_m} - 1}\right) \qquad \text{where } I_m \text{ is in ua.}$$

Method II:

20 ua offset on 15.2 db scale, using 15.2 db excess noise source.

1. Turn OFFSET CURRENT pot to OFF.

2. Turn to CALIBRATE and set to infinity.

3. Turn to OFFSET.

4. Set OFFSET CURRENT until meter reads 0.8 ma on current scale.

5. Turn to NOISE FIGURE.

6. Record the reading on the current scale.

7. Multiply the reading os Step 6 by 25×10^{-3} to get the meter current in microamperes. For instance, a reading of 2 ma is equal to 50 ua of meter current, and a reading of 0.8 ma is equal to a meter current of 20 ua.

8. Add 20 ua to the reading obtained in Step 7, and call this I_m.

9. Find the noise figure by using I_m and Table 1 or by the formula:

$$F = 10 \log_{10} \left(\frac{33.1}{\frac{50}{I_m} - 1} \right) \qquad \text{where } I_m \text{ is in ua.}$$

Method III

1. Turn OFFSET CURRENT pot to OFF.

2. Turn to CALIBRATE and set to infinity.

3. Turn to OFFSET.

4. Set the desired OFFSET CURRENT I_o. This can be read on any of the noise figure scales or the current scale, using Table 1 or the formula:

$$F = 10 \log_{10} \left[\frac{\text{Antilog}_{10} \left(\frac{F_s - 1}{10} \right)}{\frac{50}{I_o} - 1} \right] \text{ db.}$$

.... where $(F_s - 1)$ = db scale used (For the noise figure scale)

or ..... $I = 40\ I_o$ (For the meter current scale)

5. Turn to NOISE FIGURE.

6. Record the reading of Step 5. It is advisable to use the same scale used in Step 4, in order to have the same excess noise in all calculations.

7a. If the current scale is used, the reading obtained in Step 6 is $\frac{I_m - I_o}{5_0}$ ua. Solve the equation for I_m and then find the noise figure from the following equation.

$$F = 10 \log_{10} \left[\frac{\text{Antilog}_{10} \left(\frac{F_s - 1}{10} \right)}{\frac{50}{I_m} - 1} \right]$$

7b. If a noise figure scale is used, call the reading F' and solve the following formula using the correct excess noise.

$$F = \frac{(F_s - 1)^* \left[50F^* + I_o F^* + I_o (F_s - 1)^* \right]}{(F_s - 1)^* (50 + I_o) + I_o F^*}$$

....where I_o is in microamperes

$$(F_s - 1)^* = \text{Antilog}_{10} \frac{F_s - 1}{10}$$

$$F^* = \text{Antilog}_{10} \frac{F'}{10}$$

TABLE I

6 DB EXCESS NOISE			15.2 DB EXCESS NOISE			CURRENT		
NOISE FIGURE DB	##	METER CURR μA	NOISE FIGURE DB	##	METER CURR μA	CURR MA	##	METER CURR μA
0	0	10 0	3		2.84	0	0	0
1		12.0	4		3.52	.1		2.5
2	2	14.2	5	5	4.36	.2		5.0
3		16.7	6		5.36	.3		7.5
4	4	19.3	7		6.57	.4		10.0
5		22.1	8		7.99	.5	.5	12.5
6	6	25.0	9		9.66	.6		15.0
7		27.8	10	10	11.59	.7		17.5
8	8	30.6	11		13.75	.8		20.0
9		33.3	12		16.20	.9		22.5
10	10	35.7	13		18.78	1.0	1	25.0
11		38.0	14		21.57	1.1		27.5
12		40.0	15	15	24.42	1.2		30.0
13		41.6	16		27.33	1.3		32.5
14		43.2	17		30.12	1.4		35.0
15	15	44.4	18		32.79	1.5	1.5	37.5
20	20	48.1	19		35.25	1.6		40.0
∞	∞	50.0	20	20	37.50	1.7		42.5
			21		39.58	1.8		45.0
			22		41.40	1.9		47.5
			23		42.90	2.0	2	50.0
			24		44.10			
			25	25	45.35			
			30	30	48.40			
			∞	∞	50.00			

SECTION IV
CIRCUIT DESCRIPTION

4.1 OVERALL CIRCUITRY.

The basic circuits of the 792-A include amplifying, detecting, gating, and metering circuits; noise generators, and appropriate power supplies. A functional diagram is included at the end of the section.

Amplifier & Detector Circuits.

The input of the 792-A connects through a switched attenuator to an agc'd, wide band, amplifier (Q301-306) and diode attenuator (CR301-304). This is followed by a single-tuned, narrow band amplifier whose center frequency is variable over the 10 - 120 mc range of the wideband input. The output of the amplifier is detected in a square law detector (CR307) and is then AC coupled to a 2 kc wide video amplifier (Q113-118). The output of the video amplifier is clamped by a dc restorer (CR102) and fed to two synchronously operated gates - an AGC Gate (Q119) and a Meter Circuit Gate (Q120).

Gating Circuits.

The gates are operated synchronously with the noise source, and with the wide-band amplifier. A multivibrator (Q101 & 102) generates a 300 cycle gating pulse, and also pulses a bi-stable multivibrator (Q105 & 106) to produce a second gating pulse at 150 cycles. The 150 cycle pulse turns the noise source on and off.

During 2nd half the on-time of the noise source, the 300 cycle pulse turns on both the AGC Gate and the Wide Band Amplifier. The output pulse is fed to the AGC circuit and clamped at a constant value. During 2nd half the off-time of the noise source, the 300 cycle pulse turns on both the Meter Gate and, again, the Wide Band Amplifier. Now, the output pulse is fed to the calibrated meter circuit.

AGC Circuit.

The input stage of the AGC is a differential amplifier (Q109-112). One input is fed by [illegible] the output of the AGC gate through an emitter follower (Q108); the second input is a negative voltage obtained from the -6.8 volt regulated supply. This voltage is used as a reference for the AGC. The differential amplifier consists of two grounded emitter stages feeding emitter followers in double-ended fashion, to provide AGC voltages 180° out of phase. One voltage controls the series diode in the diode attenuator; the other controls the shunt diodes and the Wide Band Amplifier. The AGC loop acts on the diode attenuator and Wide Band Amplifier to maintain the detected AGC Gate output equal to the reference voltage.

Meter Circuit.

The meter is calibrated to read noise figure by measuring the detected output of the Meter Gate. The meter scale is based on the relationship:

$$F = \frac{F_s - 1}{\frac{N_2}{N_1} - 1}$$

where: F = Noise Figure

$F_s - 1$ = Excess Noise Power $\left(\frac{T_h}{T_o} - 1\right)$

N_1 = Noise OFF Power

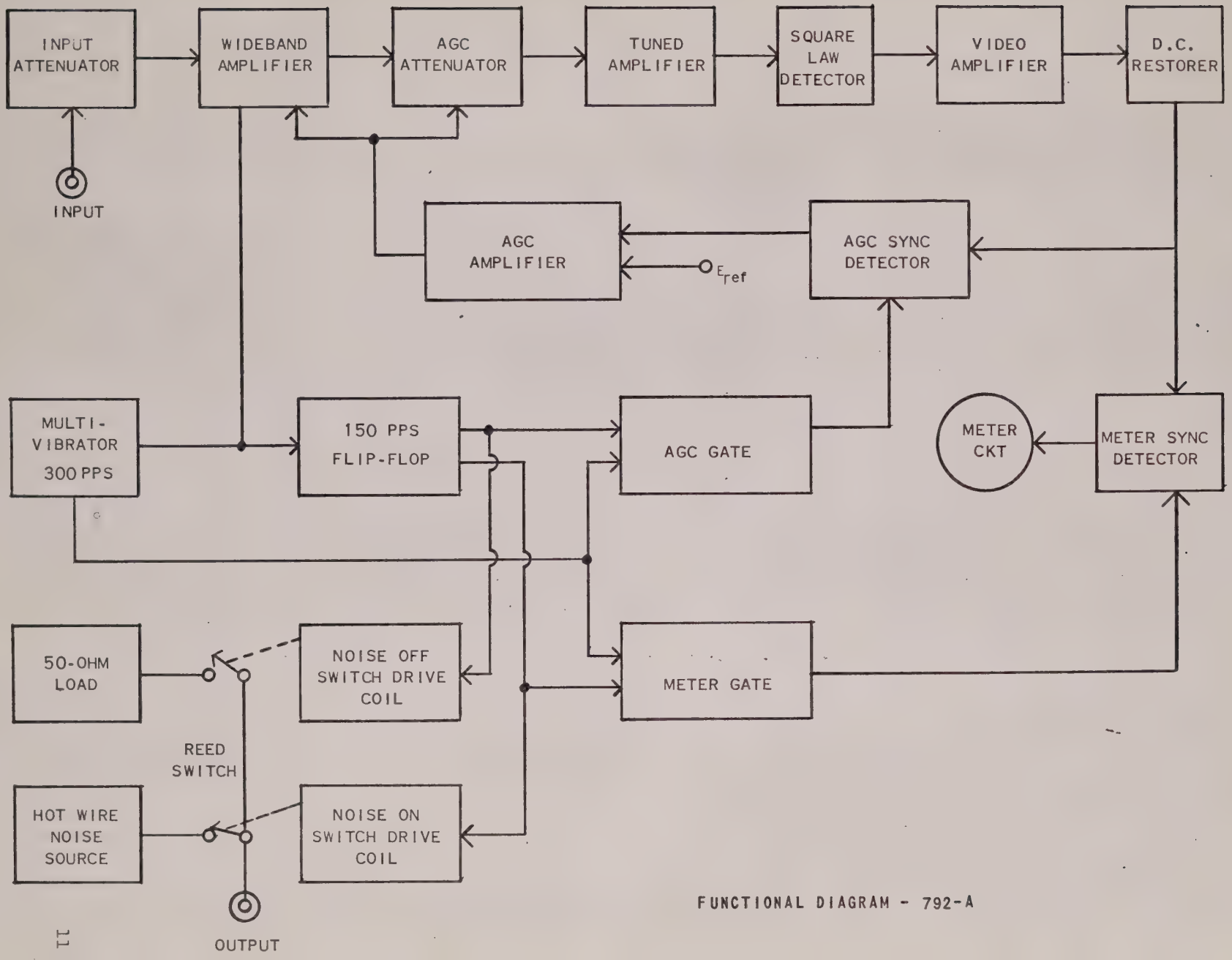
N_2 = Noise ON Power

T_h = Hot body temperature of noise source (°K)

T_o = Room temperature (°K)

....Since $(F_s - 1)$ is a constant for the particular noise source used and N_2 is held constant by the AGC Circuit, only N_1 varies and is monitored by the meter.

Calibration of the meter scale is performed by leaving the noise source on continuously while the gating circuits switch, as usual, between the AGC and Meter circuits. This establishes "infinity" noise figure, and the end of the calibrated scale.



FUNCTIONAL DIAGRAM - 792-A

SECTION V
CHECK-OUT AND CALIBRATION PROCEDURE

EQUIPMENT REQUIRED:

Oscilloscope, DC to 300 kc response.

VTVM.

Test Amplifier, with known noise figure.

A. POWER SUPPLY.

1. Measure across C203; and adjust R218 for exactly −25 volts.

2. Measure across C202, and adjust R219 for exactly + 15 volts.

3. See that there is −6.8 volts (±10%) between the emitter of Q205 and ground.

4. See that the ripple of the −25 volt supply does not exceed 20 mv p−p, and the ripple of the +15 volt supply is less than 4 mv p−p.

B. METER ADJUSTMENT.

1. With the Auto−Node 792−A turned OFF, adjust the plastic screw on top of the NOISE POWER LEVEL meter so that the needle reads as far to the right as possible.

2. Place a clip lead across the terminals of the AUTOMATIC NOISE FIGURE METER and, using the mechanical meter adjustment, zero the needle. Now, remove the clip lead.

3. Connect the Pinlite noise source to the Auto−Node and set up the equipment for a noise figure measurement on the test amplifier.

C. SQUARE LAW DETECTOR.

1. Turn the power switch to AUTO and the NF METER FUNCTION switch to CALIBRATE.

2. Adjust the COARSE and FINE frequency controls for a maximum reading of the NOISE POWER LEVEL meter. If necessary, use attenuation to make NOISE POWER LEVEL meter read in the white OPERATE area.

3. Set the AUTOMATIC NOISE FIGURE METER to read infinity, using the SET TO INFINITY control. Then switch to MAN and set the meter to infinity with the GAIN control.

4. Insert 3 db of attenuation and adjust R365 until the meter reads 6 db (center scale).

5. Repeat the two preceding steps until no further adjustment is needed.

6. Remove the 3 db of Step 4, and insert 1 db attenuation. The meter reading should fall between 21 on the top scale and 12 on the middle scale.

7. Insert an additional 5 db of attenuation and see that the meter reads 0.5 on the current scale.

D. AGC ADJUSTMENT.

1. Adjust R130 until the voltage on the base of Q112 is −3.4 volts (±0.1 volt). At the same time, keep the needle of the NOISE POWER LEVEL meter at the extreme left of the OPERATE zone by inserting attenuation from the input attenuator.

2. Observe the waveform at the junction of C105 and CR102; it should correspond to Fig. 5.1.

3. Using the internal attenuator (and external attenuation if necessary), adjust the input level so that it is just sufficient to maintain agc action. At this level, the meter will no longer read infinity when 1−db of additional attenuation is inserted.

4. Now, take 40 db of attenuation out of the circuit. Adjust the Noise Power Meter Adj (R380) until the meter needle is at the extreme right of the OPERATE zone. (This requires a test amplifier with a gain of about 75 db at a bandwidth of 1 mc.)

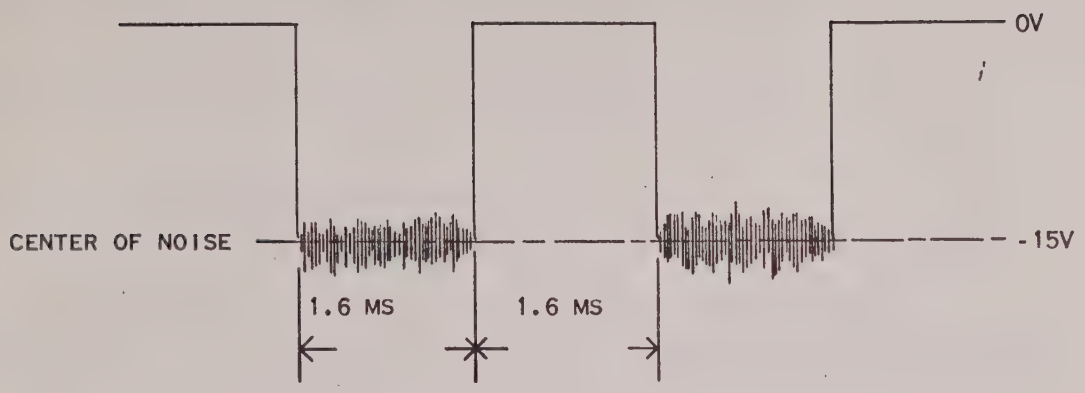


FIG. 5.1 - AGC NOISE PULSE

ADDENDUM #M-8621-C

This addendum covers two additions to the instruction manual. The following does not require any change to the schematic diagram or parts lists.

Section I, Paragraph 1.2A should read: Hot Wire Noise Head
(Pinlite Noise Source - Mod #7921-A)

Section III, Paragraph 3.1 should include:

CONTROL	POSITION	FUNCTION
NF METER TIME CONSTANT (S-3) (Located on rear apron)	FAST	Provides the Automatic Noise Figure Meter with a relatively fast response. (Not associated with the AGC time constant)
	SLOW	Damps the Automatic Noise Figure Meter provideing a slower response and more filtering of noise spikes. (Not associated with the AGC time constant)

Section III, Paragraph 3.3 should read:

Hot wire (Pinlite - Mod. #7921-A) Noise source operation.

ADDENDUM #M765-8621-C

1. Paragraph 3.1, NF Meter Function Switch S-2. Add under Position: OFFSET. Add under Function (Adjacent to Offset): Permits a translation of the Automatic Noise Figure Meter Current by a predetermined amount.

2. Paragraph 3.3, Hot Wire Noise Source Operation. Add: Turn switch on rear of 7921A to desired frequency range i.e., L: 10-250 MC, M: 200-500 MC, H: 450-900 MC (usable to 1100 MC). When not using the 7921A but the 792-A is still turned on, turn the switch on rear of 7921A to OFF to prolong the life of the 7921A hot wire source.

ADDENDUM #M665-8621C

Add to paragraph 3.3 under main title of HOT WIRE NOISE SOURCE OPERATION
"A. Automatic Operation"

Add to 3.3 A-1 "Turn Power Switch to AUTO"

Change Section 3.5B - Method II

7. Change "Call this (1) " to "Call this (I)."
8. Change Formula to read:

$$10 \text{ Log } 10\left[\frac{Fs-1}{(2I-1)}\right]$$

Fs-1 = Excess noise of the tube as a multiplier (Not DB)

9. Change from ".....value of 1 closer to ....." to ".....value of I closer to ....."

Change formula to read:

$$10 \text{ Log } 10\left[\frac{Fs-1}{(aI-1)}\right]$$

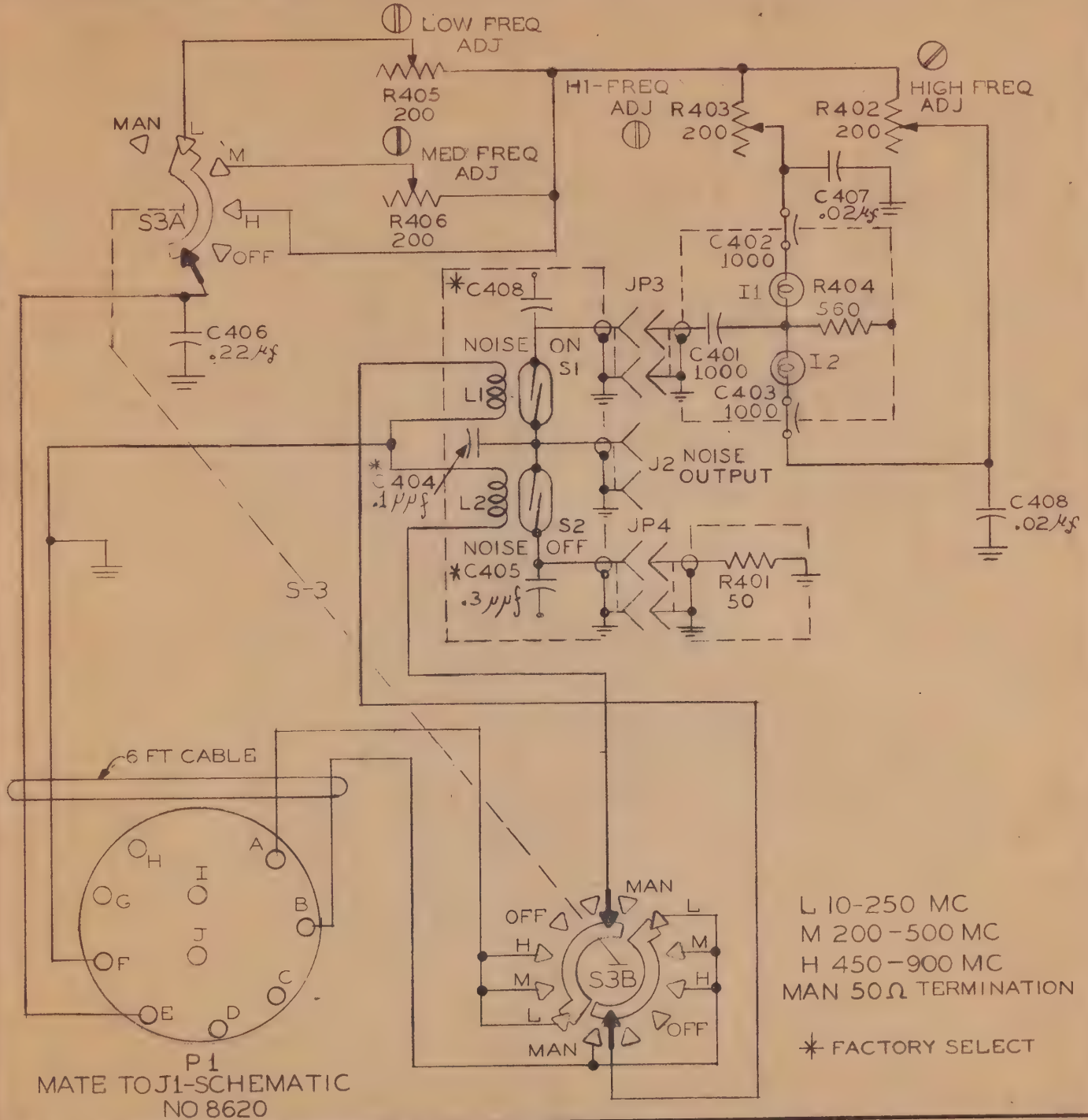
Change Method III

6. from "Insert a 3 DB pad....." to "Insert a pad of attenuation a between....."
7. from ".....formula ($S=\frac{2}{1}$) where 1 is ....." to ".....formula ($S=\frac{2}{I}$) where I is ....."
8. Change formula to read:

$$F=10 \text{ Log } 10\,(Fs-1)\left[\frac{(a-s)}{as(-1)}\right]$$

Add to end:
a is a multiplier (Not DB)

NC - 780 HEAD IS NO LONGER AVAILABLE



SCHEMATIC PINLITE NOISE SOURCE — AUTO-NODE MOD 792A

MAT. | FINISH: | SCALE:

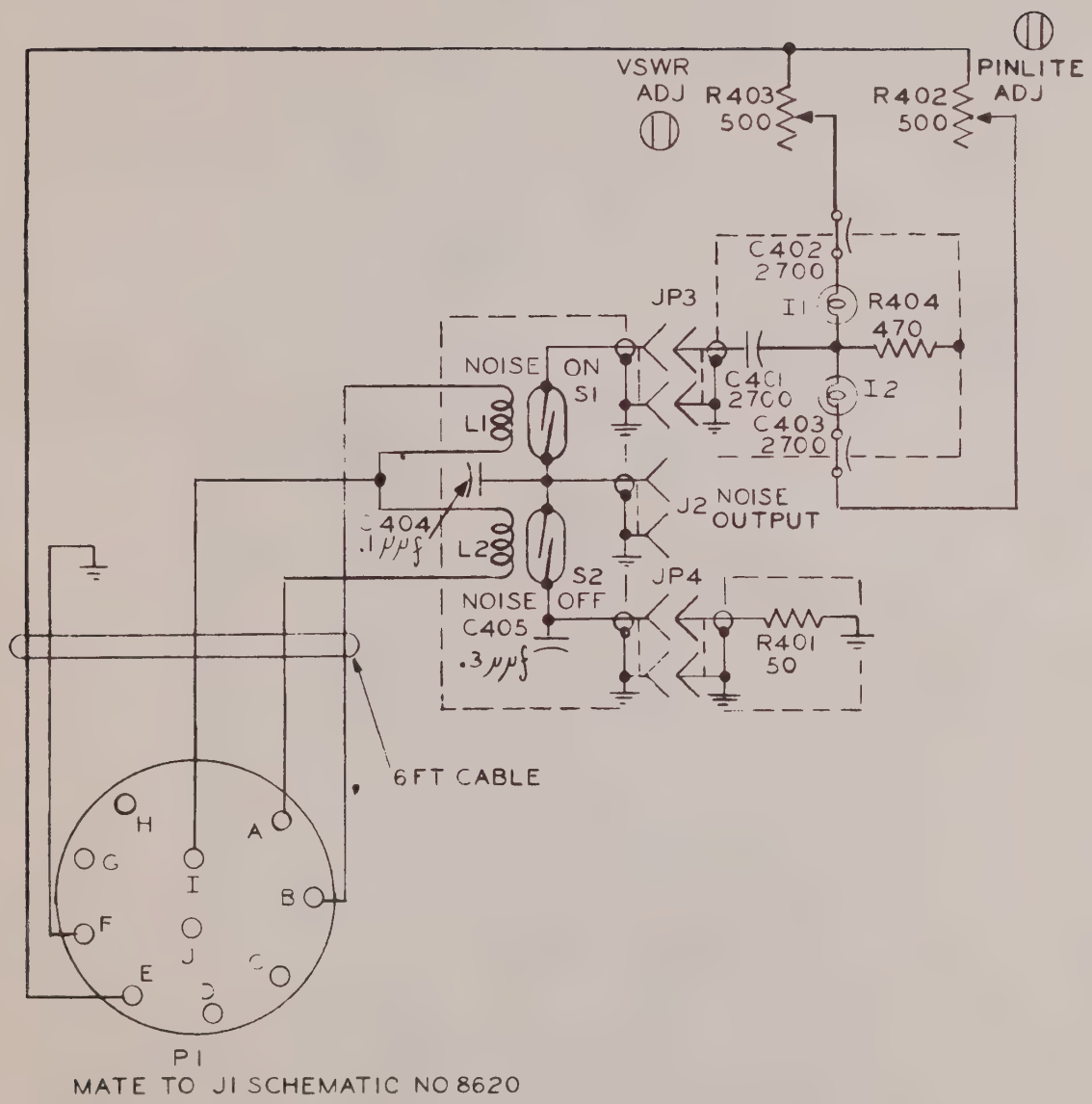
TOLERANCES UNLESS OTHERWISE SPECIFIED:
DECIMAL ± .005 FRACTIONAL ± 1/64 ANGULAR ± 30 MIN.

CHANGE	DATE	APP.
"B" C405 WAS .27 μμf	6-3-64	
"C" ECN #886	8-18-65	
"D" ECN 914	8-1965	
"E" ADDED SWITCH S3-D, ADDED *C408	11-9-65	

KAY ELECTRIC CO.
PINE BROOK, N. J.

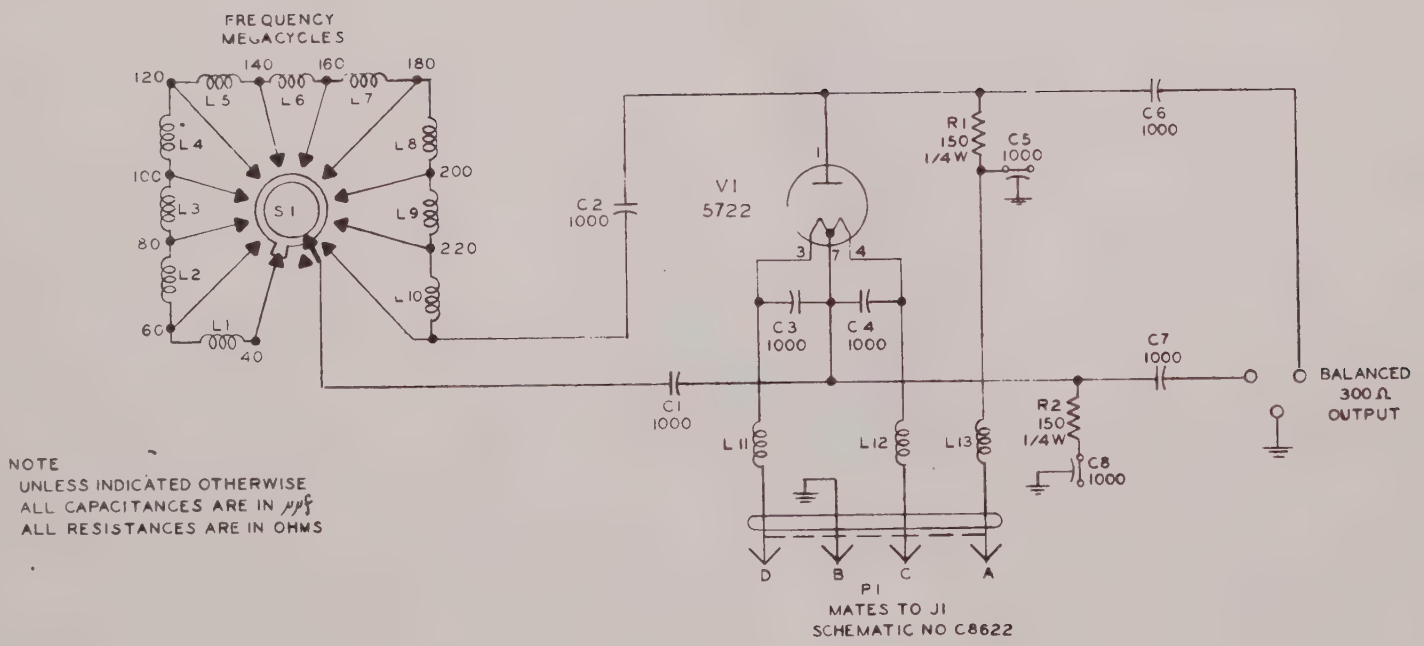
DWN. BY AWP DATE 5-19-64
APP. BY DATE 6-2-64

DWG. NO. A 8635 E



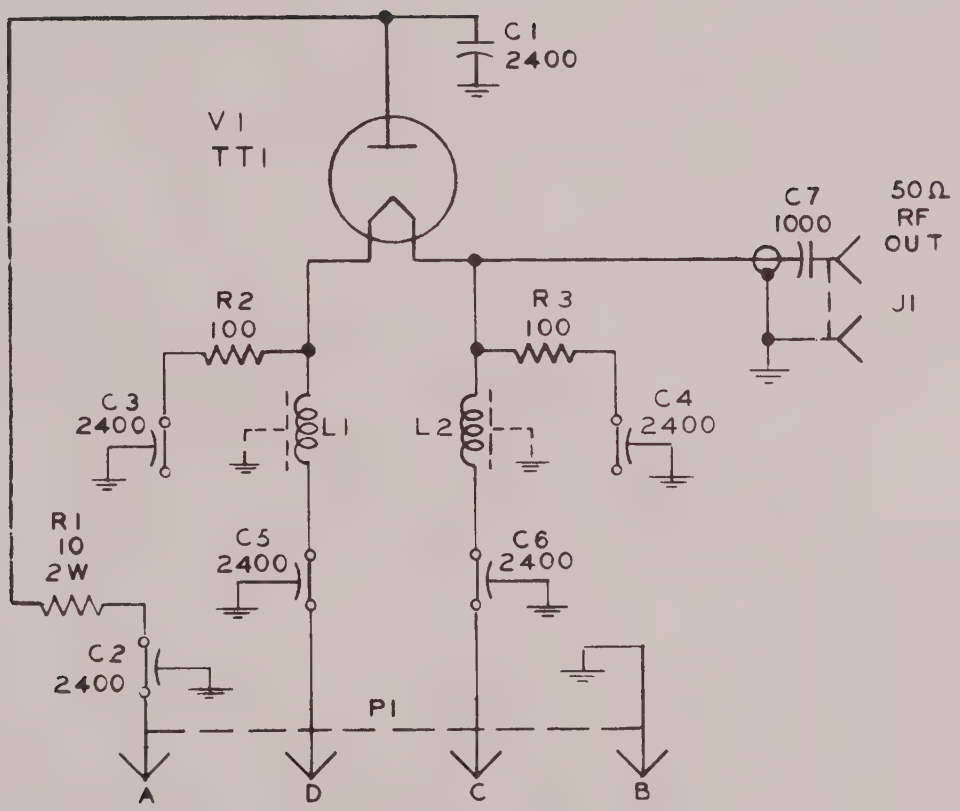
SCHEMATIC, PINLITE NOISE SOURCE A-8635-B

OBSOLETE



NOTE
UNLESS INDICATED OTHERWISE
ALL CAPACITANCES ARE IN μμf
ALL RESISTANCES ARE IN OHMS

NOISE HEAD 300 OHM BALANCED NB300 B-8829-A



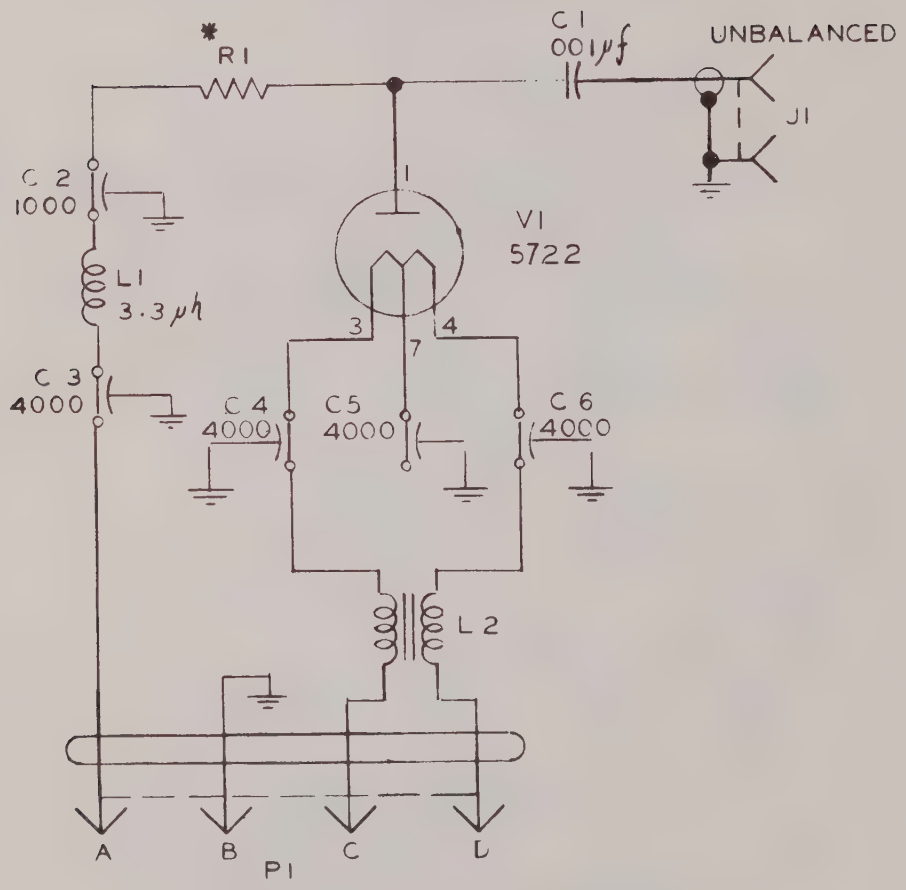
P1 MATES TO J1

SCHEMATIC NO 8622

50 OHM NOISE HEAD TTI NC780, A-8824-A

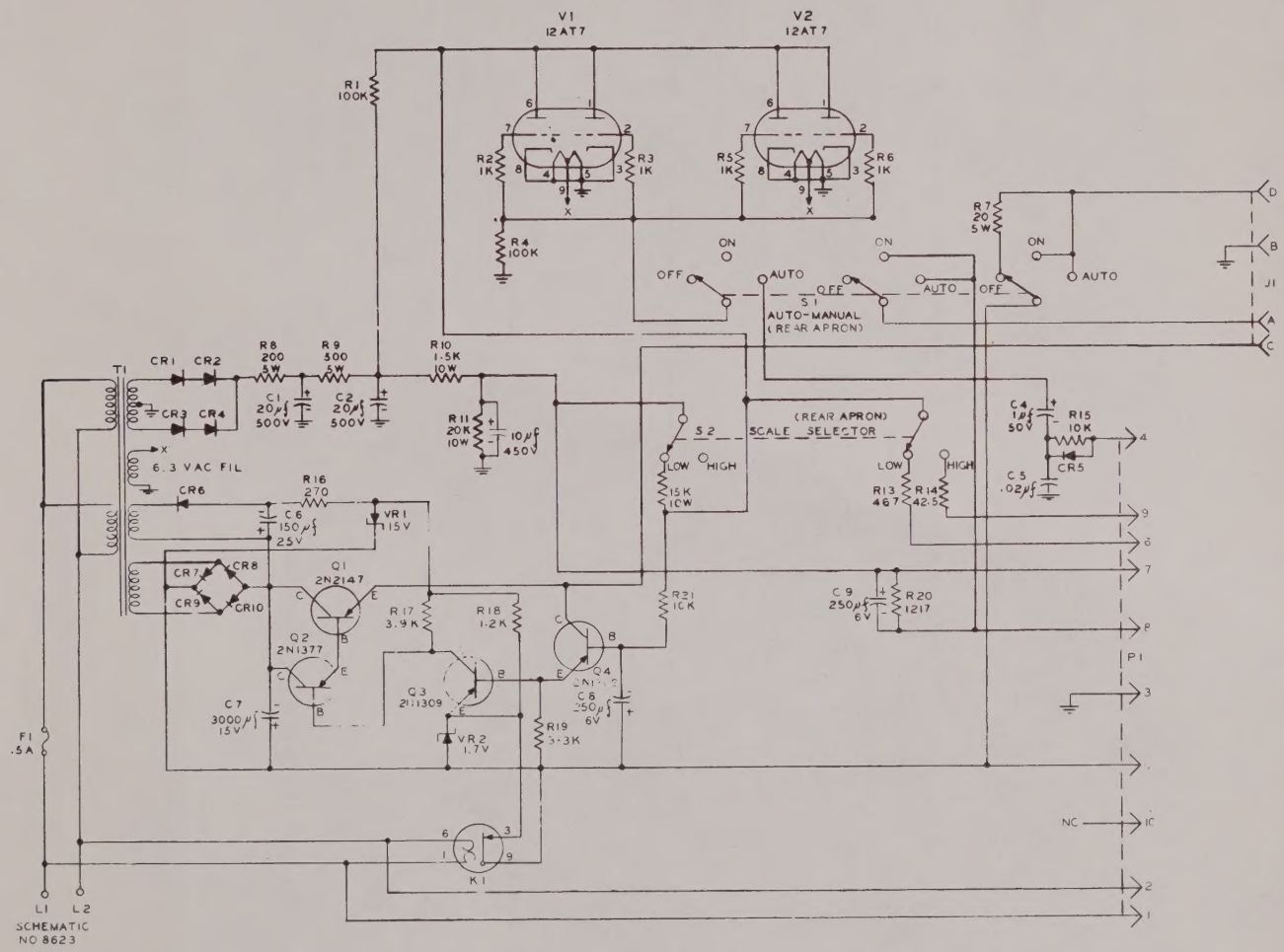
OBSOLETE

* FOR IMPEDANCE REQUIRED
50-70-75 OR 91Ω

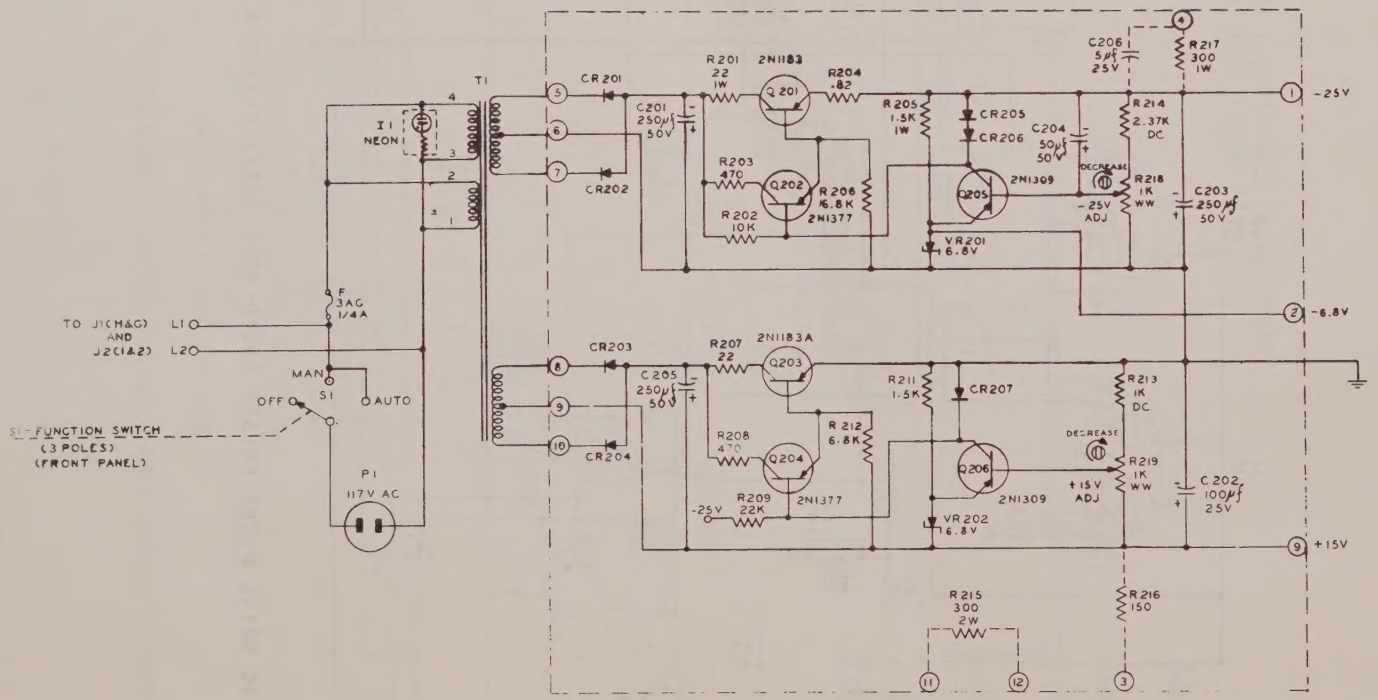


MATE TO J1
SCHEMATIC NO C8622

TEMPERATURE LIMITED NOISE SOURCE NC240, A-8827-A



SCHEMATIC NOISE DIODE PULSER (AUTO-NODE 792A) C-8622-A



SCHEMATIC POWER SUPPLY (AUTO-NODE 792A) C-8623-A

MP MASTER
MA34848

SE Laboratories
LOC: MM3
MAN – 06141